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ABSTRACT

This paper deals with the use of personal technologies in decentralized university education. Decentralized education, delivered to off-campus students located in the same geographical area, is a hybrid genre combining features of both on-campus and distance education. The paper reports two studies. The first study focused on communication patterns among students in a regular decentralized education setting. It was shown that: there are obstacles preventing the students from developing communities of practice, and some of the obstacles are likely to be eliminated with personal technologies helping the students to get access to various resources and to communicate with each other. The second study included providing a student group with a set of PDAs and analyzing the impact of the technology on students' learning and communication patterns. The prospects for using personal technologies in decentralized education are discussed. (Contains 26 references.) (Author)

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Supporting decentralized education with personal technologies

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Abstract: The paper deals with the use of personal technologies in decentralized university education. Decentralized education, delivered to off campus students located in the same geographical area, is a hybrid genre combining features of both on campus and distance education. The paper reports two studies. The first study focussed on communication patterns among students in a regular decentralized education setting. It was shown that (a) there are obstacles preventing the students from developing communities of practice, and (b) some of the obstacles are likely to be eliminated to alleviated with personal technologies helping the students to get an access to various resources and to communicate to each other. The second study included providing a student group with a set of PDAs and analyzing the impact of the technology on students' learning and communication patterns. The prospects for using personal technologies in decentralized education are discussed.

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Introduction

Online courses and educational programs provided by universities for off-campus students have become increasingly popular during the last decade. One of the main factors contributing to the widespread interest in online courses is the freedom that the students are assumed to have when choosing time and place for their learning activities. The transformation of traditional learning into the so-called "e-learning" follows other general societal trends induced by information and communication technologies (ICT), such the trends towards e-commerce, e-democracy, and e-government. For universities the idea of a virtual campus has been put forward as a possible solution to the problem of overcrowded classrooms that impose constraints on on-campus teaching and learning. New demands for virtual campuses have also been articulated by regions and municipalities, which want to set local university programs to meet the needs of their local labor markets.

The changes in university education are associated with new challenges for teachers. Many teachers have to combine traditional on-campus teaching with giving distance courses or hybrid types of courses, such as decentralized ones. The trend toward extending university education beyond campuses also has an impact from students' perspective. On-campus education takes place in a setting that evolved from centuries of experience with supporting traditional classroom teaching. The setting provides a coherent context that is rich in various types of resources crucial for successful teaching and learning. These resources include a possibility for students to participate in a variety of regular classes, communicate with fellow students, have an access to university library, and various types of advanced technological resources (currently they often include a high-speed connection to the Internet). Besides, on-campus settings are characterized by physical presence of teachers, counselors, student unions, and so on. This context supports an enculturation process, so that the students can develop different communities of interests. On the other hand, in case of decentralized education and distance education, there is a limited access to resources, such as library facilities, teachers, computer capabilities, connection to the Internet, etc. Besides, there is often no predominant context for teaching and learning, as it is in the case of on-campus education. Students participating in decentralized university education have to study in a number of contexts, not only in formal educational settings, such as a local study center, but also at home, at workplace, on a bus, etc. Since students' learning activities are distributed over both time and space, it is more problematic to establish communities of interests. As a result, for many distance/decentralized education students learning is a more lonely process than it is for on-campus students.

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Universities have been provided with information and communication technologies supporting the structural changes towards "more virtual" educational settings. Many discussions related to the educational use of technology have been focussing on finding standard ways of successfully using hardware and software depending on a certain course content. However, when education becomes more diverse other demands also come into the foreground. Given that the learner-centered teaching and learning perspective is crucial for education, and that there are profound individual differences between students in mental processes underlying learning and cognition (Gardner, 2000), it is necessary to take into consideration the specific contexts and circumstances, in which students live and study. According to Reigeluth (1999) in development of educational settings and pedagogical methods it is important to focus on customization instead of standardization. If customization is to be taken seriously, one has to recognize that proliferation of diverse educational forms forces students and teachers to become more mobile, in the sense that the context where those actors act changes all the time. Further, teachers have to be aware that students who attend their courses have different motives and prerequisites. Implementation of educational technologies in education has to deal with the above issues and complicated contexts. Finally, one more consequence of the customization perspective is that the traditional top-down approach to creating learning environments, that is, an approach, according to which webmasters and technicians construct an ICT-based environment, should be replaced with an alternative "bottom-up" approach, when teachers and students are more actively involved in the design process.

"The best way to support learning is from the demand side rather than the supply side. That is, rather than deciding ahead of time what a learner needs to know and making this explicitly available to the exclusion of everything else, designers and instructors need to make available as much as possible of the whole rich web of practice- explicit and implicit, allowing the learner to call upon aspects of practice, latent in the periphery, as they are needed" (Brown and Duguid, 1993, p 13)

The starting point for both this paper in general and the project reported below has therefore been an attempt to investigate from a students' perspective the technologies they actually use and how communication and behavior patterns evolve with the use of different media. One of our previous studies (Hedestig and Orre, 2002) showed that students communicate through other channels than can be traditionally found in ICT-based learning environments. In particular, the use of mobile phones has become very common in the last several years. The majority of the students participating in the study reported in this paper (that is, 31 out of 32 students) had mobile phones. A promising type of tool to support students in learning settings typical of decentralized education could therefore be mobile artifacts, since certain types of such artifacts have been already adopted by students and they are flexible enough to deal with the complex nature of the reality of distance and decentralized education, mentioned above.

A case for personal technologies

In recent years mobile artifacts, such as mobile phones and handheld computers (PDAs), changed our ways of interacting with colleagues and friends. There is an appealing "aura" around these devices attracting people interest and stimulating the willingness to use them. With a tremendous speed and smoothness mobile technologies have been assimilated in our working life, as well as our everyday life. However, what are the attributes and the features of mobile technologies? Before we answer this question it is necessary to define what we mean by mobile artifacts. We would like to address the notion of personal technologies as it was introduced by Sharples (2000) and relate it to our discussion of mobile artifacts. According to Sharples (2000), mobile technology can be considered as a subset of personal technologies. Personal technologies in a broad sense include several other technologies. The main feature of various personal technologies is that we use them for organizing our everyday life. Digital date books or PDAs contact lists on IRC clients and mobile phones provide some examples of personal technologies. In this paper we will discuss characteristics of mobile technologies, which, from our point of view, can have an impact on the design of learning environments.

Characteristics of mobile technologies

Contextual features of mobile technologies are related to processes and factors at the micro-social level, that is, interactions among and between people (Townsend, 2001). Interpersonal interactions are the domain

where we find the most challenging and intriguing characteristics of mobile technologies. For instance, Kopomaa (2000) describes the mobile phone user as a newly emerged flaneur reclaiming public places and sites. Due to the ability to get mediated access through mobile technologies people are free to choose where and when to interact with others, and place is no longer a restriction. Rather, choosing or finding a place became a routine issue that parties involved in a conversation via a mobile phone have to deal with, often being influenced by rules and habits inherited from fixed-line communication. Interpersonal interactions are dynamic and undergo developmental changes, so that people face a special problem of maintaining relations with other people through different means. In the past fixed-line telephones, postcards and letters were used, in addition to face-to-face meetings, to maintain relationships. Today, even though we still use fixed-line phones, it is mobile phones, e-mail, and different types of instant messaging systems that are more often chosen as a communication channel. Postcards and letters are still playing some role but their use decreases due to decreasing costs and efforts related to the use of alternative media.

Maintenance of personal relations is one aspect of personal technologies, relevant to their use in education. Another aspect related to contextual features that needs to be taken into consideration is the possibility of micro-coordination. With mobile technologies we can co-ordinate our activities with others more easily. This is a type of the use of technology that can be found among young people as well as among families. If one drives home from school and stops by a grocery store, a brief phone call from one's mobile phone can help to decide what to buy and bring home.

Flexibility is a feature that can be discussed and analyzed from different perspectives. Mobile artifacts, such as handhelds or mobile phones, have both a personal dimension and a public dimension, supporting activities taking place during either leisure or working time. Greenberg, Boyle and Laberge (1999) refer to personal artifacts as those that are owned by one person and public artifacts as those that are created and collectively owned by co-operating group members. The above distinction can be exemplified by a student group working with an assignment, where each student can use his or her handheld to access two types of repositories: (a) personal repositories, e.g., contact lists, personal files and notes, and (b) public repositories, e.g., course schedule, class discussions, and other resources from the common information spaces. It is important to take into account that there is a tension between these domains. What is socially acceptable in one setting is not necessary acceptable in another one. Sharples (1999) describes mobile technology as potentially disruptive when use patterns collide with established norms and values. The example he gives is a mobile phone ringing in a classroom. The signal is irritating both for the owner himself, who feels guilty for forgetting to turn off the device, and for the teacher and fellow students, who experience an interruption of the lesson.

Mobile technologies play different *roles* in different situations. The user and the needs that currently are the most important ones determine a specific role to be taken. For instance, Ling (2001) illustrates different motives behind adopting mobile phones through the following example. Imagine that someone, person X, travels from point A to point B. For X a mobile phone can be a safety device giving a feeling of security while traveling if something happens. For people who are waiting for X at point B a mobile phone can be used, if needed, to notify X that they are going to be late. Besides, people at point B can be confident that if something happens to X, he or she will notify them, as well. Ling & Haddon (2001) discuss motives such as accessibility, display, coordination and security/safety indicating that these motives have generational bounds and social needs that is determined by contextual perquisites. These and other examples clarifies the role and the mediated effect of mobile technology to extend beyond the tool view.

Thus, personal technologies, such as mobile phones, may play numerous important roles in our society. Studies show that these technologies answer to the needs and hopes of the modern individual and incorporation of these technologies into our way of life is a two-way process. Not only is the device being adapted to our everyday practices; our practices also change as a consequence of the use of technologies (Hedestig, Orre, 2002).

Mobile technologies in learning settings

Teachers become mobile due the fact that higher education undergoes similar structural changes as industry does, when considering the effects of the development towards the information society. Virtual universities often create new demands for teachers' mobility by introducing new forms of education. Decentralized education and distant education, for instance, force teachers to travel to give lectures and provide assistance to students. Maintenance of resources connected to a course, as well as maintenance of relations with fellow teachers can only be done by means of different technologies that overcome constraints associated with time and place. At the same time, it is necessary for the teacher to perform micro-coordination with the family as

well. Existing technologies in learning environments lack the flexibility necessary to deal with all these circumstances, and therefore teachers have to adopt other technologies in order to attain these goals. One candidate technology for supporting teachers in mobile work settings, which we mentioned and discussed above, is a mobile technology integrating public and private environments.

Students are as well affected by these changes, since education becomes more virtual and accessible "anytime, anywhere". Students engaged in decentralized and distance education are more differentiated in age, background, etc, comparing to students participating in on-campus courses and programs. This means that teaching and learning, as mentioned above can occur in different places (e.g., at home, on campus, or at work places). In these environments different means of communication and collaboration are necessary. Existing technologies can lack appropriate features to support informal and formal communication. The learning process contains highly situated and collaborative elements, and the place of learning can be defined as the place where connections to social networks exist and are accessible (Hedestig, Orre, 2002).

Since late 90s there has been an increased use of mobile phones among all age groups (Ling, Vaage, 2000). New communication patterns have emerged with the advent of these devices and new cultures of use have been built around these technologies. The phenomenal success of adopting these devices in everyday life of millions of people can be used as a promising and potentially instructive example in designing architectures of new learning environments. Recently there has been a growing interest in the use of personal technologies in education, especially within K-12 settings, where these technologies open up new possibilities for children to get a better access to different resources (Danesh et al 2001). The traditional way to use computers in education has been to make computers centrally located, e.g., in computer labs. Such an arrangement has resulted in a limited access to technology for students. Since placing computers in one specialized location isolates them from other educational settings, the technology has been almost exclusively used for computer-oriented activities and not for domain-oriented or subject-oriented activities (Inkpen, 1999). Recently a number of pilot projects tried to find out how personal technologies can be integrated into a wide variety of learning settings. These projects have focused on specific issues, for instance, tests and assignments (Chen, Myers and Yaron, 2002), collaborative learning (Landay 1999, Roschelle and Pea 2002, Luchini et al 2002), and distributed training of medical students (Lundby, 2002).

Mobile technology and competence development in work settings has also been a popular topic of research since the late 90's. The work conditions in the "information society" have been recognized as demanding more distribution and mobility of the work force (Kristoffersen and Ljungberg 2000) In IT-based work settings mobile workers need new types of competence development opportunities, which are not restricted by time and space. Several recent research initiatives have been initiated to face this challenge by focusing on new models of using mobile technology in competence development (Hardless et. al, 2000) and supporting knowledge management (Fagrell, Forsberg and Sanneblad 2000).

A mobile learning project

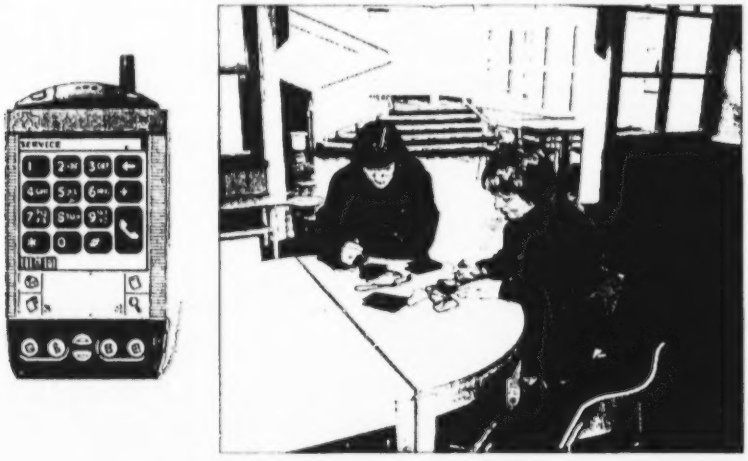
A project reported in this paper was initiated at the Department of Informatics, Umeå University, during Fall 2001 (Orre, Hedestig, Kaptelinin, 2001; Hedestig, Kaptelinin, 2001). The aim of the project was to understand existing communication patterns and use of mobile artifacts among undergraduate students and how this knowledge can be used to inform design of learning environments for distance and decentralized education. The project had adopted a bottom-up approach to designing learning environments, that is, attempted to view teaching and learning from students' perspective. In other words, the goal was to understand how students learn and interact with each other. A class of 32 students in a town located 150 km from the University campus attending a decentralized undergraduate program in Informatics took part in the project.

Framing Communication Among the Students

The first phase of the project was to deal with how the students socialized and communicated within a group of classmates. The aim was to reveal student's communications patterns and then capitalize upon this knowledge when introducing PDAs and further investigating the impact of technology on students' learning activities. Every student participating in the project was asked to keep a diary of his or her communications. The students recorded to whom and when and by what media they communicated. The diary data allowed us to reveal several patters of communication showing how different groups within the class emerged and evolved.

Another source of empirical data were interviews used to cross check the data from the dairies and to capture aspects that were hard to find in the dairies. Interviews were both conducted with students either in small groups or individually. We found group interviews a useful technique both as a source of new data and as a cross-reference to the dairies and the individual interviews. The interviews were recorded and then transcribed.

The second phase of the project was to focus on the adoption process. Twenty PDAs were distributed among the students approximately three months after the initiation of the first phase. We video-recorded the distribution of the PDAs the students in order to get hold of their initial response in the first encounter with the devices. We followed up the introduction with individual interviews conducted, respectively, one week and two weeks after the distribution. All PDAs were equipped with a mobile phone Springboard module, which enabled the students to use PDAs as a mobile phone and connect their PDA to the Internet. One reason for combining PDAs and the mobile phone module was our belief that the hybrid bridging two worlds - the world of the PDA and the one of mobile phone - is one of the most promising directions of the development of mobile technology. The objective of the study was an investigation of the feasibility of the artifacts for problem solving and the attitudes of the students, including their feelings and concerns experienced during the use of the devices in their studies. An important goal of the project was an attempt to integrate the above devices in the student's everyday life and make these devices a natural part of the ecology of learning environments, and thereby follow the developmental process of the mobile technology in use.



a) b)

Figure. 1. (a) The personal technology employed in the study and (b) a typical use situation.

Supporting Horizontal Communication

Due to a lack of resources available at a local study center, the students have formed study groups that regularly met and provided an important support for individual learning. In these groups a work practice had developed, where some students would take the role of a teacher and help the others to deal with the problems and difficulties they encounter. The traditional models of communication between the teacher and students, which are typically based on the idea of vertical communication, did not apply to the above interactions in study groups. Participating in the study groups was shown to influence students' attitudes towards technologies used in education. For instance, sending e-mails to the teacher was perceived by the students as a rather formal means of communication. It was also considered too slow in terms of receiving prompt replies to students' questions. It took a few days for the teacher to deliver an answer, and by then, the question was usually already discussed and dealt with in a study group. Therefore, the answer given from the teacher was more of a confirmation of the solution already developed within a study group. The emergence of study groups indicates the need for supporting horizontal communication in order to maintain and coordinate educational activities, both formal and informal. It can be concluded that the flexibility of means supporting horizontal interaction is an important

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resource helping students to deal with the variety of contexts in which they learn. It was found that the observed increase of frequency of communication over the course of the study could be attributed to an increase in communication through horizontal communication channels (Hedestig, Orre, 2002). The students used these channels when studying at home or being located at some other place than the study center. In either case the mobile technology described above supported the students in being connected to networks of peers and being a part of a community of learners.

Our findings indicatess that in decentralized learning settings there are patterns of the use of information and communication technology, which are not adequately supported by existing technologies. Despite having an access to a variety of information and communication technologies, such as email and course websites, which are common artifacts in distance education, students preferred other, more mobile technologies in their interaction with each other. It can be concluded that decentralized education setting, heavily relying on more synchronous interactions, requires the participants to be more mobile

The Students Adoption of Mobile Technology

After distributing the set of PDAs we have carefully followed the process of adoption of this technology by the students. Our data indicates that the strategy of adopting the technology, employed by the students, was successful and the students have incorporated the PDA in their everyday life in a number of ways. We found that high motivation of the students, based on their interest in technical artifacts, positively affected the process. The students began to practically use the artifacts in an early state of the adoption process. The use of the calendar provided by the PDA replaced the use of ordinary calendars. Even those students, who never used a calendar for scheduling and planning their activities before, started to use the PDA as a digital calendar. It was also found that earlier experience of the students with mobile phones was one of the factors affecting their initial rejection of the mobile phone module. Due to low speed of transmission and low quality of the speakers of the module, which were inferior to the ones typical of conventional mobile phones, the majority of the students rejected the module in the beginning. Later on (in spring 2002) many of the students who rejected the phone module started to use it since they found new possibilities of using it in their everyday life. The PDA itself has been a success with the students. Our interviews indicate that the students especially appreciated the color screen, processing speed, and other advanced technical features. An interesting finding was that the hybrid device provided to the students was not considered as a single unit. The students always referred to a PDA and a mobile phone module as two different devices.

We identified two types of patterns in the students' process of technology adoption. All students had an intensive exploration phase in the beginning of the process. After that about 2/3 of the students started to use the PDA practically in their everyday life, while the rest (approximately 1/3 of the students) continued their exploration (Jacobsson och Jonsson, 2002). Even though initially the applications run on the PDA were only single-user applications, the process of technology adoption cannot be considered a purely individual process. It can be seen as a socially distributed activity. The students actively shared their experiences with each other, for instance, by exchanging software, encouraging each other to try new features of the technology, and providing help.

Conclusions

The studies reported in this paper call for three main conclusions. First, they show that there is an apparent need for personal technologies in education. Analysis of existing communication patterns among undergraduate students taking part in decentralized education had revealed a number of needs that cannot be addressed by current technologies. Decentralized education to a large degree consists of what can be called "mobile learning". Accordingly, the students need to get an access to course materials, to the teacher, and to fellow students when being located in a wide range of physical and social contexts. Currently the students have to rely mostly on conventional mobile phones, which have substantial limitations as a mobile learning technology. Therefore, first conclusion from our studies is that there is certainly a niche for new types of personal technologies, such as PDAs, in decentralized education settings.

The second conclusion based on preliminary results of our pedagogical intervention, in which a set of PDAs was provided to a group of students, deals with the adoption of technology. Our data shows that assimilation of personal technologies into everyday practices of students does not happen immediately. The

group is appropriating the technology over the course of developmental changes underwent by their learning activity as a whole.

Third and finally, our data indicate that the most important problems with personal technologies are related not to the technologies themselves but to the type of coordination between personal and public artifacts and between individual and collective learning activities that can be supported with personal technologies (cf. Kaptelinin, Cole, 2002). The criteria of what is a useful and usable personal technology depend on the social context of decentralized learning. For instance, the possibility to send email messages or use an instant messaging system, provided by PDAs, is important not only because it allows a student to get in touch with a teacher or other students. Mobile phones can also be used for communication between participants in a decentralized course. However, as opposed to mobile phones, PDAs allow for establishing communication without violating rules and norms existing in the social context. A student can potentially get a prompt reply from a teacher without the distraction associated with the use of a phone. Therefore, designing successful personal technologies for decentralized education requires that, on the one hand, an understanding of the social context of this type of educational setting and, on the other hand, a coordinated development of technological support for both individual and collective learning activities.

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